■ GP-6W ■

Green Power Lab
User's Manual

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1. Green Power Introduction

1. The Earth's energy has been over-exploitation. We can not take anything just like before. One day, when energy depletion of the earth, we will face a crisis of survival.
   So, we are looking for efficient and renewable energy andnd formed a global trend of green renewable energy worldwidely.

2. Moreover, green renewable energy has become popular in the world. Many countries also set this topic as a major industrial goal. We are starting with theory and practice to create a complementary experimental platform which makes everyone can join trend.

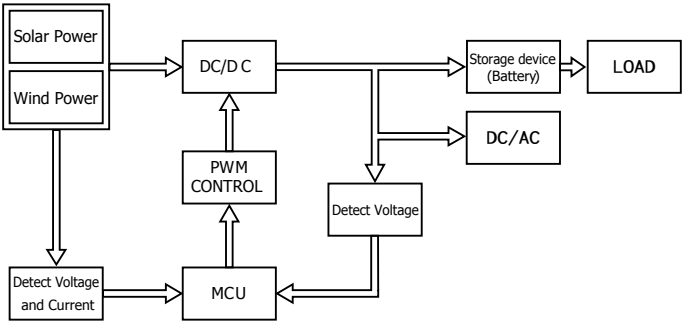
3. The GP-6W is the green energy renewable energy experimental platform. It applicate solar energy which is the most representative. It should be the best base knowledge for the academic education students. From this, we can create more and wider application of technology.

2. GP-6W Overview

Product appearance

Product inside

1. The GP-6W is a entry for the solar energy conversion platform. In order to allow users to understand the "Maximum Power Point Tracking"(MPPT), we added the single-chip feature that allows users to make changes for the "MPPT algorithm, " Thus, a better understanding of the recycling of green energy.
2. Use of solar panels received the voltage and current to understand the features of I / V, V / P and the curve with MPP and convert them into other applications.
3. GP-6W solar system block diagram.

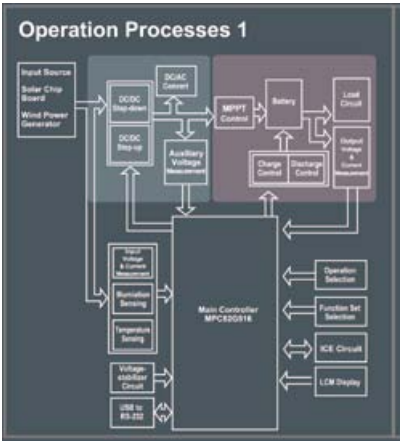


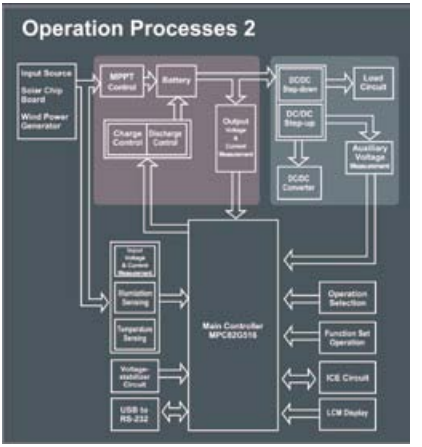
4. Features of GP-6W:

1. Application of MPPT algorithm.
2. LCD shows the input/output voltage, current and power value.
3. DC to DC converter module for learning of module transduction.
4. DC to AC inverter module convert output experiment.
5. Able to use MPU for power adjust control system. Use C or Assembly language which make the teaching easier.
6. Learn the regeneration use of solar power through the charging module.
7. Learn the regeneration use of solar power through load module. Ex, LED shining.
8. Based on open design. User can change the operating procedure during the experiment.

3. Introduction for each unit

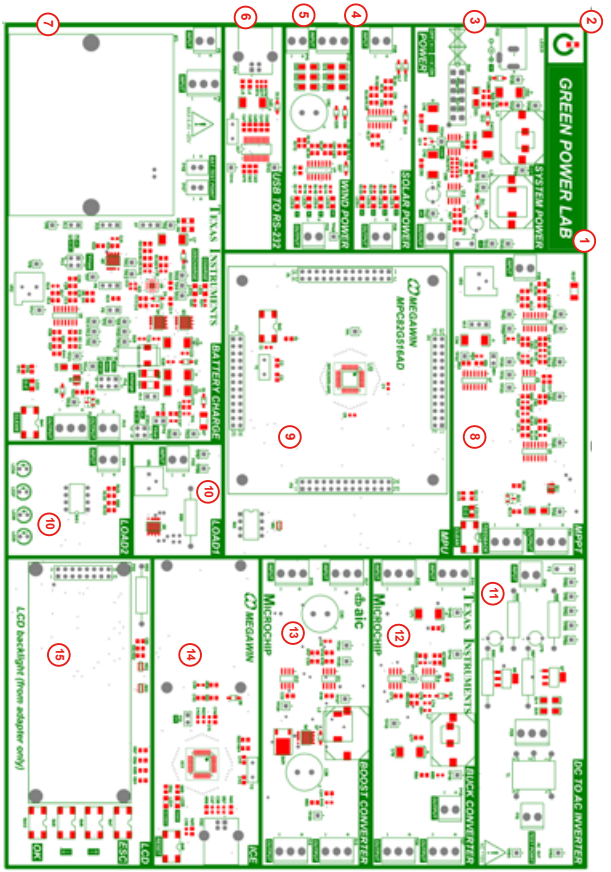
1.GP-6W System circuit block diagram

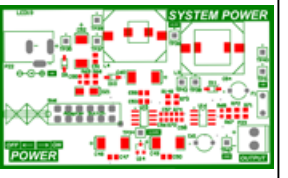
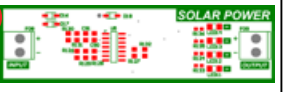




2.Platform

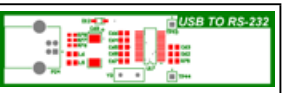
There are 15 areas on the GP-6W.

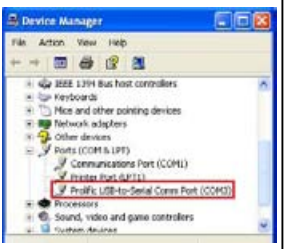


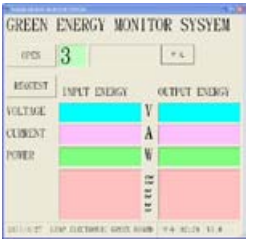
1.GREEN POWER LABModel name GP-6W	1
2.LED19 DC power ON\OFF indicator. ON is red. Use the SW6 for DC in control switch. Or by other power supply, eg, USB, the LED will light as well.	2
3.ADAPTER POWER IN power circuit P22 for the DC input DC 9V ~ 12V (MAX), It uses the step down IC which provide the stable voltage source +3.3V for system normal use, and via the step up IC to increase +3.3V to +5V for linear circuit use.	3 
4.SOLAR POWER The solar input detective circuit. It will light LED11~LED14 by the voltage up or down.	4 
5.WIND POWER Wind input detective circuit. It will light LED15~LED18 by the voltage up or down. There are 2 inputs, one is rectified which is point P41, the other is un-rectified which is point P40.	5

6.USB TO RS-232

The PC USB directly communicate with the platform.
We can down load the driver from http://www.prolific.com.tw or use we have provided. Please decompress the file of PL2303_Prolific_DriverInstaller_v130.zip and install it. Insert the Lab USB to PC to get the COM from the device manager. Shown as the image COM3.







7.BATTERY CHARGE

The battery charge circuit., the no. 3 charge battery box. The charge input is from P5 or P6. The maximum is 20V. If directly connect the solar panel, can set the value of MPPT voltage. The charge voltage/current and MPPT voltage can be set freely.

P30 JUMP default charge voltage is 6V when it on the first level. You can change the P30 JUMP to the second level. Insert the resistance to P46.

Formula:VBAT=2.1V X (1+499K / R)

The default of MPPT is 6.4V when the P16 JUMP on the first level. You can insert the resistance to P14.

Formula: IBAT=40mA / R

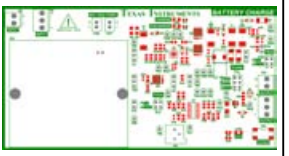
The default of MPPT is 6.4V when the P13 JUMP on the first level. You can insert the resistance to P12.

Formula: Vmpp=1.2VX (1+499K / R)

The output of the charge circuit is able to directly connect to LOAD for testing. There is detective circuit for voltage and current on the output of charge circuit. When the MCU detect the over-current, will start the OCP function. The LED3 will light and the put will be cut. SW4 is for reset function.

✻ Please take off the battery if you are not doing experiments to avoid over discharge.

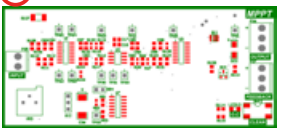
7



8.MPPTDetection of solar energy input voltage and current changes. As the main controller for the MPPT.

There is detective circuit for voltage and current on the output of charge circuit. When the MCU detect the over-current, will start the OCP function. The LED10 will light and the put will be cut. SW12 is for reset function.

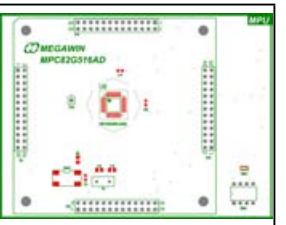
8



9.MPU control unit

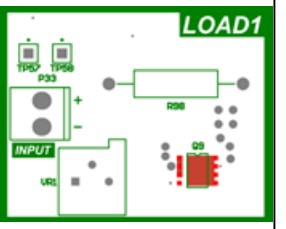
The main controller is MPC82G516 which is 1T of 8051. Inside is 64KFLASH-ROM and 256-RAM+1K-XRAM.

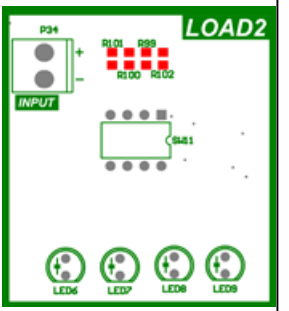
P1~P4 are the jump which make all of the MPU I/O connect to the outside. You can change other MPU module for testing.SW2 For system reset.



10. LOAD1 and LOAD2 experiment

This is for the battery input load experiment which is for understand the change of voltage(V) and current(I).



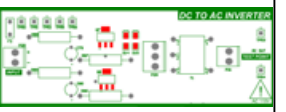


11. DC TO AC INVERTER

After fully charge, do the convert experiment for AC110V.

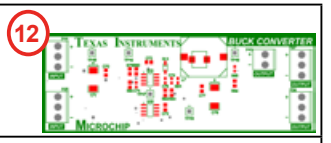
Please step down the input voltage to 2V and connect to P28.

* When you are doing this experiment, please do not touch TP53 and TP54.



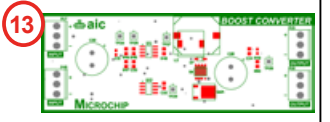
12. BUCK CONVERTER

TPS54321 adopts Buck current connection. It is via MPU to control U18 digital resistance for adjusting the output voltage which is within 20V.



13. BOOST CONVERTER

AIC1628 adopt Boost circuit connection. It's via MPU to control U18 digital resistance for adjusting the output voltage which is within 20V..



14. ICE

The main controller programming and the debug program devices of J25 DFU must to keep open. When its short-circuit, it means to update 84FL54 internal program. We have program the ICE in the factory, Please insstall the ICE driver to the KEIL C folder.

(* When using ICE download program, you can use the vendor provided IcpProgrammer.exe to update the compiled HEX to MCU. For Keil C users, please install ICE driver to Keil C file.)

15.LCD 1602C It's for the disply purposes of operating functions switch and the detection for voltage and current.

The display defaults are as below.

(1) Boot screen: Company Name

(2)DIP-SW: SW1 4 sets DIP switch status display

(3)INPUT SENSOR: solar energy or wind power input voltage and current detection

(4)OUTPUT SENSOR: the battery output voltage and current detection

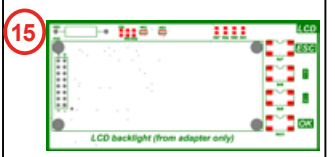
(5)TEMP & LIGHT: simple detection of temperature and illuminance

(6)BUCK TEST: the feedback of the detection value for the step-down circuit test

(7)BOOST TEST: the feedback of the detection value for the boost circuit test

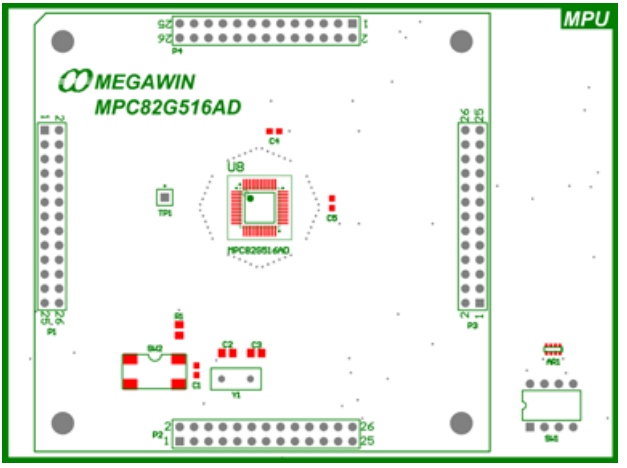
(8)LOAD TEST: the test for voltage and current of the battery output to the load

(9)RS232 TEST: the Lab USB link to PC. Able to observe the solar input voltage and current, and the battery input voltage and current from the man-machine interface



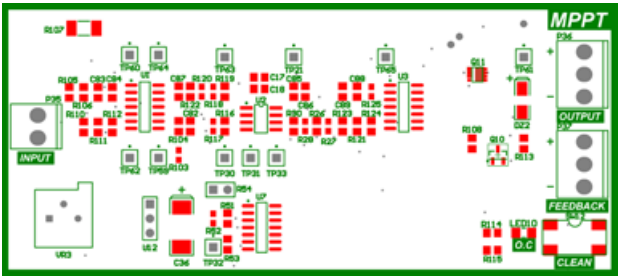
Experimental Processes:

1.DIP-SW experiment



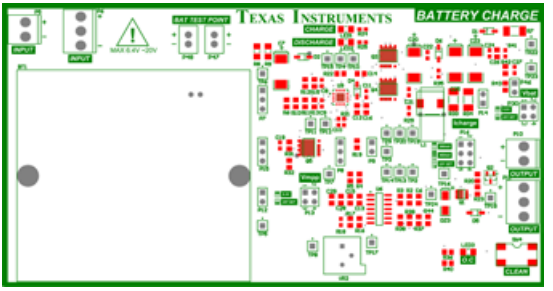
Press SW8(+)or SW9(-)switch to LCD DIP-SW. Press SW10(ENTER key). The order is P23 P22 P21 P20, OFF is 1, On is 0.

2.Input Sensor Experiment



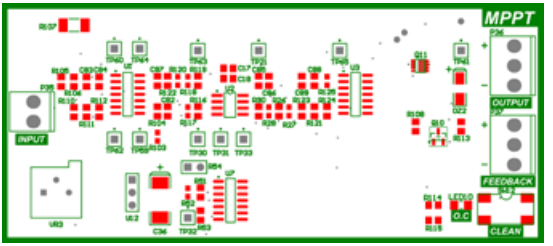
The solar board or wind power input from P35. Press SW8(+)or SW9(-)switch to LCD, For input sensor, press SW10(ENTER key), will show the solar or wind input voltage and current on the LDC

3.Output Sensor Experiment



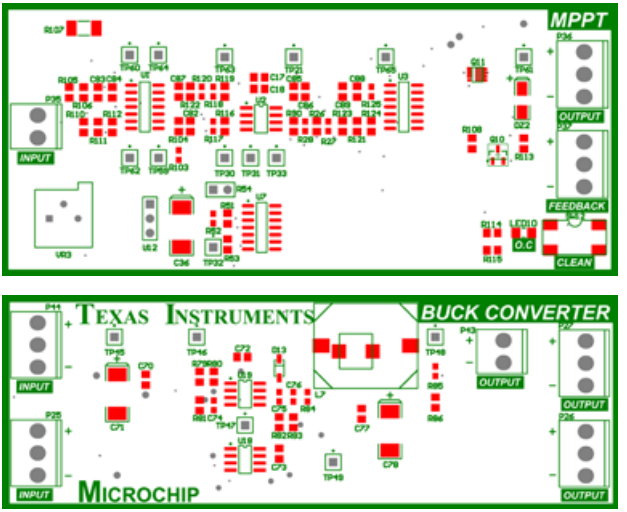
Install the no. 4 battery. Press SW8(+)or SW9(-)for switching to LCD display. For output sensor, press SW10(ENTER key), will show battery voltage and current on the LCD.

4.TEMP & LIGHT experiment



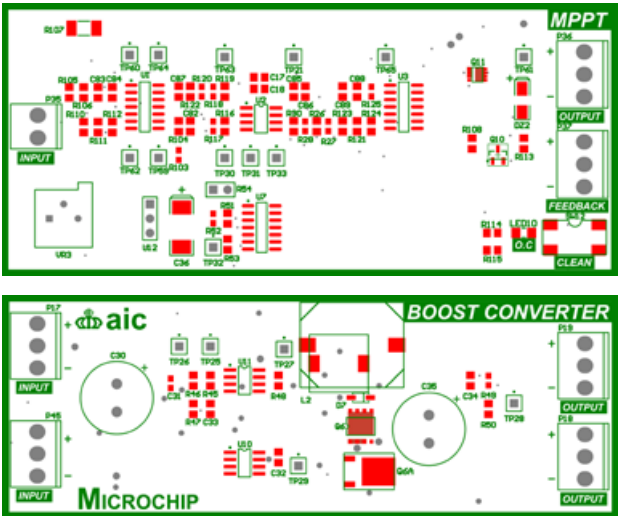
Press SW8(+)or SW9(-), switch to LCD show TEMP LIGHT. Press SW10(ENTER key), will show the U12 temperature and the illumination value of R51 sensor photoresistor. (This temperature value and the illumiance values are only for for the reference, not completely accurate.

5.BUCK TEST experiment



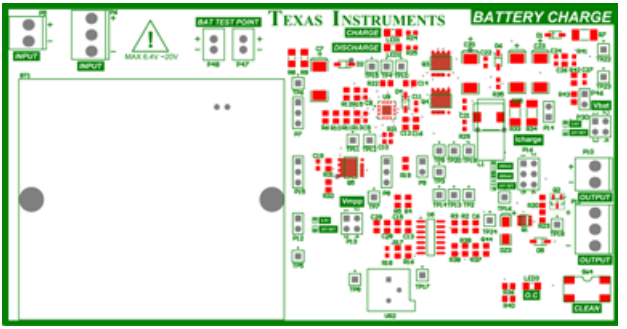
Input from the solar power or wind power P35. Connect P36 to P44 or P25 (BUCK module input). Connect P26 or P27(BUCK module output). Connect to P37(detect feedback voltage). Press SW8(+)or SW9(-)to switch to LCD display. Press SW10, ENTER KEY for BUCK TEST. You can see the voltage and current on the BUCK module. The digital resistor control default is 128. We can press SW8(+)or SW9(-) for adjusting the voltage up and down.

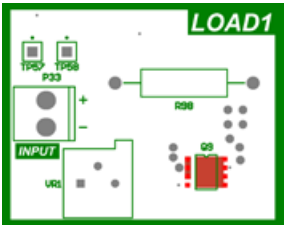
6.BOOST TEST experiment

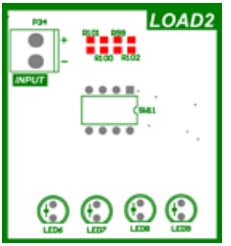


Input the solar power or wind power from P35. Connect P36 to P17 or P45 (BOOST module input). Connect P18 or P19(BOOST module outpur)to P37(detect feedback voltage). Press SW8(+)or SW9(-)to switch to LCD display the BOOST TEST. Press SW10(ENTER key), you can see the voltage and current of the boost module on the LCD. The digital resistor control default is 128. We can press SW8(+)or SW9(-)to adjust the voltage up and down.

7.LOAD TEST experiment

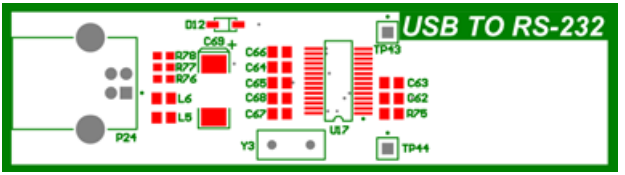


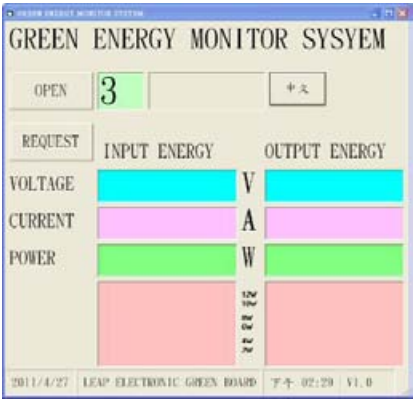




Install the 4 pcs of no. 3 battery. Please make sure they are fully charge. Connect P10 or P11 to P33 or P34 for Load experiment. Press SW8(+)or SW9(-)to switch to LCD display LOAD TEST. Press SW10(ENTER key), we can see the battery voltage and current on the LCD. When connect to P33, the MOSFET VGS voltage can be changed by turning the VR1. We can observe the change of the battery voltage and current. When connect to P34, it can switch SW11 DIP to open the LED6~LED9. We can observe the change of battery voltage and current.

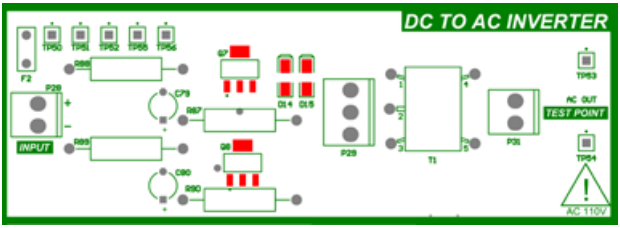
8.RS232 TEST experiment





Connect PC USB to P24. Click the human HMI software Project1.exe. Select the right USB COM PORT, press the start button. Press the SW8(+)or SW9(-)switch to LCD display RS232 TEST. Press SW10(ENTER key). We can observe the voltage and current power curve on the PC.

9.DC TO AC experiment



Input the solar power or wind power from P35. Connect P36 to P44 or P25 (BUCK module input). Connect P26(BUCK module input)to P37(detect feedback voltage). Press SW8(+)or SW9(-)to switch to LCD display BUCK TEST. Press SW10(ENTER key). We can see the BUCK module voltage and current. The digital resistor control default is 128. We can press SW8(+)or SW9(-)to switch voltage to 2V. Connect P27(BUCK module output)to P28. Press SW8(+)or SW9(-) to adjust voltage up. We can use DSO or meter AC to observe AC voltage and waveform of TP53 and TP54 for verifying the DC to AC function.

- If the wind generation kit does not through rectifying for voltage input, must through wind bridge module for rectifying. Please connect the wind generation kit input to P40, rectifying output to P42. Connect P42 to P35 for other experiments. If already rectified, we can directly contact the wind generation kit input to P41. Connect P42 to P35 for other experiments.

- We will enter the protection mode for the below conditions.

  1.If P35 input current over 2A, the LED10 red will light up. It means enter the protection mode. The system will forbid P36 output. We can reset SW12 and SW8(+)for recovery ON condition.

  2.If the battery output current over 1.4A, the LED3 red will light up. It means enter the protection mode. The system will forbid P10 and P11 output. We can reset SW4 and SW9(-)for recovery ON condition.

- During the experiment, if crash, we can directly press the RESET key (SW2) for recovery.

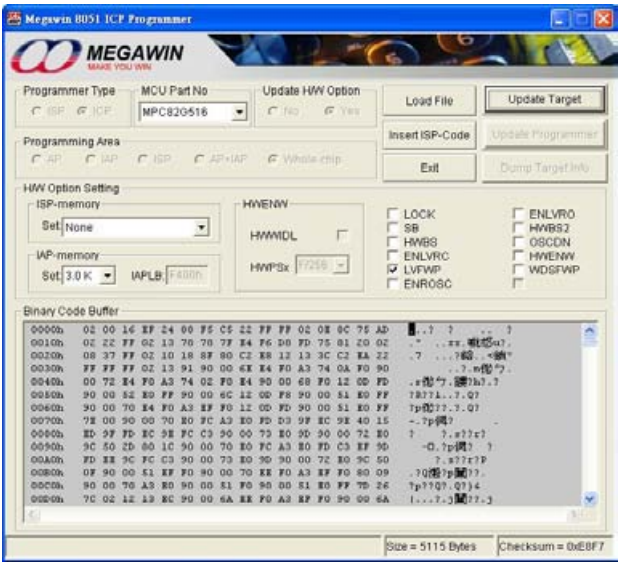
The procedure of using ICE module to download the HEX to MCU:

1. Execute ICP Programer.exe

2. Select MCU part no. of MPC82E516

3. Click Load File for selecting down load program.

4. Click Update Target for download the program to MCU.

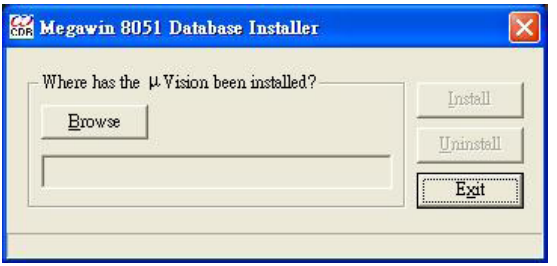


If using ICE module via Keil C debug program, must install ICE driver to Keil C file.

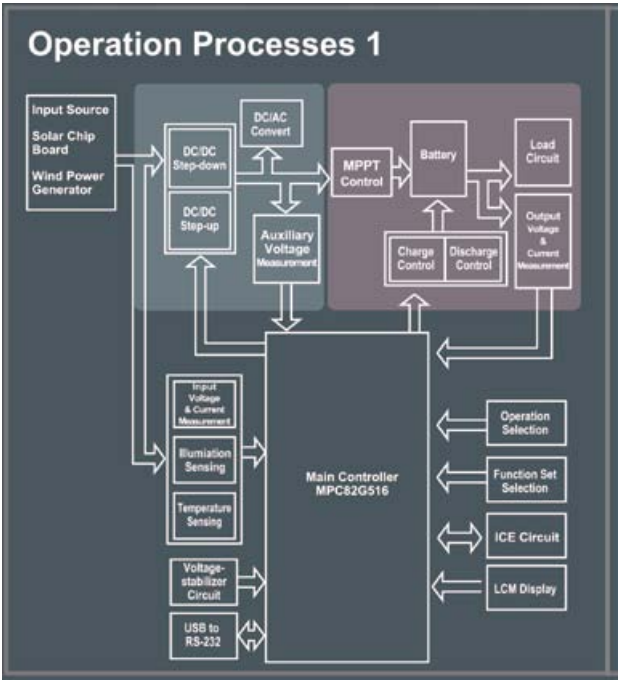
1.Execute the setup.exe which is on the file 8051_OCD_ICE_For_Keil_v2.50-1\(1) Database Installer.

2.Click Load File to load Keil C.

3.Click Install and finish it.



4. The Testing way of MPPT



The Design of Perturbation & Observation(P&O) (Hill-climbing)

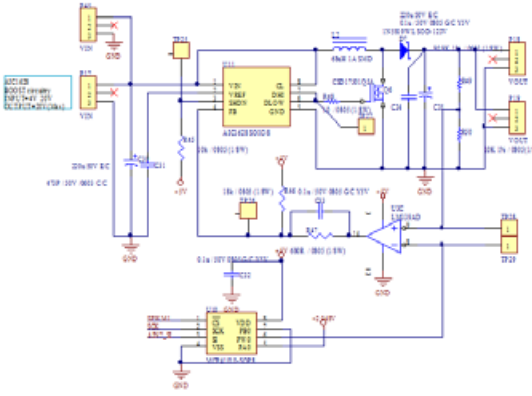
As the sunlight intensity change is similar to ambient temperature change which is a slow processl, the sampling is no need high real-time, once every a few seconds will meet the requirements. The sampling interval can be adjusted. The initial is short for quickly approaching the Pmax. The follow can be longer, which can prevent the system oscillate around the Pmax. To prevent the system error, we set 3 times for each controlled comparison. Only when the results of the 3 times are consistent, the corresponding control strategy can be implemented, or to re-

sample comparisons. Thus, it ensure the system normal operation extramely.

1 The Hardware Circuit

Connect the solar board to P38 input. Connect P39 to P35 for detecting voltage and current. Connect P36 to the BOOST circuit input P17 or P45. Connect the BOOST circuit output P18 or P19 to P37 which is feedback detective voltage. Connect another BOOST circuit output P18 or P19 to a LOAD test which is for imitating the charging status.

The P&O method is needed to change the load amount to match with the internal resistance of solar cells in order to achieve the Pmax. However, the real load impedance is usually not easily programmable change. We replace it by the PWM duty cycle of the DC / DC in this experiment. In general, the greater of PWM duty cycle need the greater current. It will make the output load of solar energy larger (the output impedance becomes smaller). whereas, the PWM duty cycle smaller, the output impedance becomes larger. For a boost module, the output voltage will increase with the PWM duty cycle larger. Therefore, if make the feedback resistor smaller, the PWM duty cycle will be larger.



The another reason for using the step-up module is when the solar sell output voltage is small, still can increase the voltage through the step-up module, which

make able to charge to the sell. So that, the energy can be used, will not be wasted.

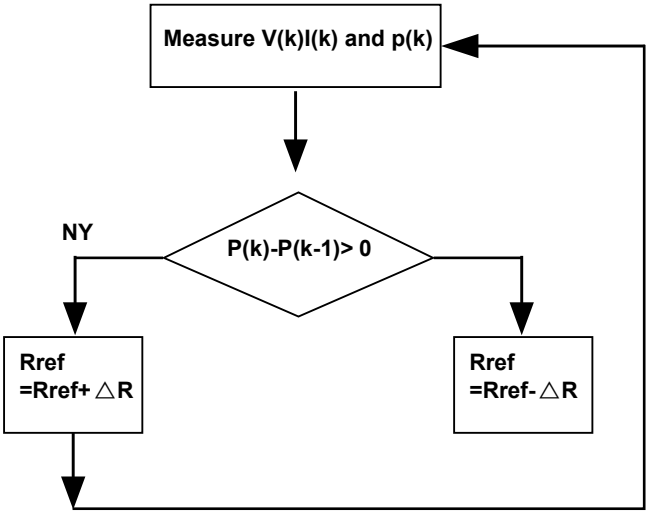
(1)1-3.2 The Software Design of P&O

The digital resistor is through the SPI interface to set. After power on, the resistor is 5K ohm. When setting, lower the CS pin first. Then, through the SI to send DATA (16bit), SCK is sent to the 16 pulses. , Write_Res (cs, dat) to cs said that a DC / DC (0 for step-down, 1 for step-up), dat is resistance value (255 for 10K), formula is (dat/255) * 10K, spi. c programs are listed is as follows.

```
#define CS0  P4_5        //1
#define CS1  P4_6        //1
#define SCK  P4_1        //2
#define SI   P1_7        //3
#define SPI_Delay() _nop_();_nop_()
void Write_Res(unsigned char cs,unsigned char dat)
{
 unsigned char temp,i;
 temp=0x11;  // command
 SCK=0;
 if(cs==0)
 {
  CS0=1;
  CS0=0;
 }
 else
 {
  CS1=1;
CS1=0;
 }
 SPI_Delay();
```

```
 for(i=0;i<8;i++)
 {
   if((temp & 0x80)==0)
                SI=0;
else
                SI=1;
SCK=1;
SPI_Delay();
SCK=0;
temp<<=1;
 }
 temp=dat;
 for(i=0;i<8;i++)
 {
   if((temp & 0x80)==0)
                SI=0;
               else
                SI=1;
               SCK=1;
               SPI_Delay();
               SCK=0;
               temp<<=1;
 }
 CS0=1;
 CS1=1;
}
```

(2) The P&O method control process is shown as the below. The reducing of the reference resistor is equal to the increasing of the PWM. Do not forget when doing the design



P&O method control process

(3) Because no need to calculate real-time, we adopted polling ADC. It use timer to generate the timer flag (once every 5 seconds). Only when the flag is set, then go to measure and calculate the operation point. The MPPT control processing programs are as follows.

```
// MPPT processing
// P&O
void  MPPT_Process()
{
  unsigned char i;
  for(i=0;i<3;i++)                    // for 3 times
  {
    Sensor();                         // polling read sensor for display
    IN_Read();                        // input convert
    ppin[1]=pv*pi;
    if(ppin[1]>ppin[0])               // power enlarge
    {
      dstime=0;
      ustime++;

      if(ustime>2)                    // 3 times satisfied
      {
        ustime=0;
              rref=rref-DRES;                 // resistor reducing,
              if(rref<DRES) rref=DRES;        // range limit
              if(dctype==0)                   // buck
                 Write_Res(0,rref);
              if(dctype==1)                   // boost
                 Write_Res(1,rref);
              ppin[0]=ppin[1];                // renew record

            }
}
    else
{
```

```
            ustime=0;
            dstime++;
            if(dstime>2)                    // 3 times satisfied
            {
              dstime=0;
        rref=rref+DRES;                     // resistor reducing
        if(rref>(255-DRES)) rref=255-DRES;  // range limit
            if(dctype==0)
              Write_Res(0,rref);
            if(dctype==1)
              Write_Res(1,rref);
            ppin[0]=ppin[1];                // renew record
          }
}
  }
}
```

(4) The system main process is responsible for the sampling and LCD data display. When mflag = 1, doing once MPPT calculations. The main programs are as follows.

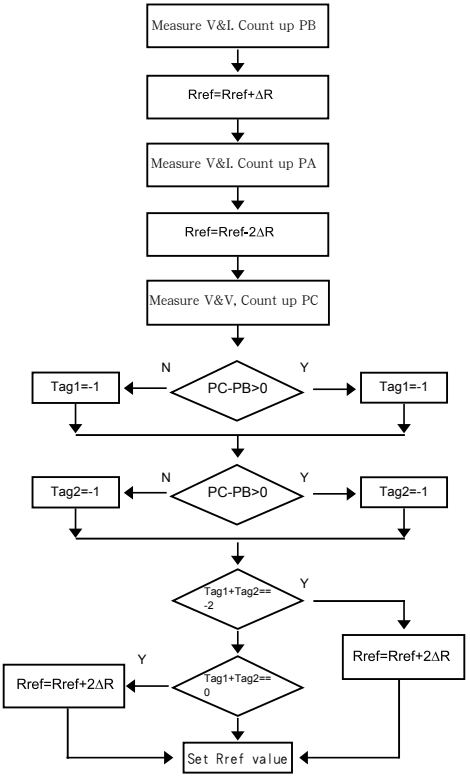
```
void main(void)
{
  IO_Init();                                // IO initialization
  System_Init();
  Setup_Check();
  if (dctype==0)          // buck
    Write_Res(0,rref);
  if(dctype==1)                             // boost
    Write_Res(1,rref);
  LCD_Init();                               // LCD initialization
  Delay_ms(100);                            // delay 0.1 sec, wait LCD finish
  LCD_Cmd(0x80);                            // specify to row1 column1 of LCD
  CHARGE=1;                                 // charge switch ON
  DISCHARGE=1;                              // discharge switch ON
```

```
  Delay_ms(100);                    // delay 0.1 sec

                                                          // record first power
  Sensor();              // polling reading sensor for display
  IN_Read();                                    // input convert
  LOAD_Read();                    // output convert
  ppin[0]=pv*pi;

  while(1)
  {
    Sensor();            // polling reading sensor for display
    IN_Read();                    // input convert
LOAD_Read();                          // input convert

if(OSHORT_flag==1)        // input short circuit feedback 3_5
{
            if(OSET==0)
     {
       OSHORT_flag=0;
       disp_buf2[13]='D';
             DISCHARGE=1;
     }
}
if(ISHORT_flag==1)       // input short circuit feedback P3_5
{
            if(ISET==0)
     {
       ISHORT_flag=0;
       disp_buf1[13]='C';
             CHARGE=1;
     }
}
if(P3_6==0)                                          // change display content
{
            Delay_ms(10);              // delay
```

```
                if(P3_6==0)
                {
                  if(dispmode==0) dispmode=1;
                  else dispmode=0;
                }
}
    Message();
if(uart_received_finished==TRUE)

{
                rs232_process();
                uart_received_finished=FALSE; // process finished
}
if(MPPT==0)                    // do MPPT
{
                MPPT_flag=1;
                if(mflag==1)
                {
                   MPPT_Process();   // MPPT process
                   mtime=0;
                   mflag=0;
                }
}
else
              MPPT_flag=0;
  }
}
```

2. Three-point-weighting comparison(TPWC)

(1) As the below chart, measure B point data first. And then, after reducing the Δ PWM, and measure A point. Increase the double of Δ PWM, and measure C points. Then, determine the TAG and decide the PWM to increase or decrease.
(refer the resistor increasing or decreasing.)



TPWC control chart

(2) Hardware circuit

Set as the previous.

(3) TPWC program design

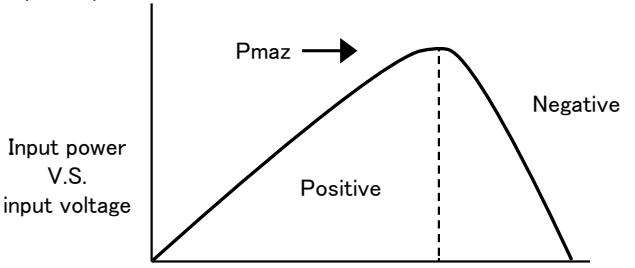
Main program as below. The below is only for MPPT program.

```
// MPPT manage
// TPWC
void  MPPT_Process()
{
  Sensor();              // polling for reading sensor value for display
  IN_Read();                          // input convert
  ppin[1]=pv*pi;                  // B point power
  rref=rref+DRES;                 // decreas PWM
  if(rref>(255-DRES)) rref=255-DRES;  // range limit
  if(dctype==0)
    Write_Res(0,rref);
  if(dctype==1)
    Write_Res(1,rref);
  Sensor();                  // polling for reading sensor value for display
  IN_Read();                              // input convert
  ppin[0]=pv*pi;                   // A point power
  rref=rref-2*DRES;           // increas PWM
  if(rref<DRES) rref=DRES;             // range limit
  if(dctype==0)
            Write_Res(0,rref);
  if(dctype==1)
            Write_Res(1,rref);
  Sensor();                  // polling for reading sensor value for  display
  IN_Read();                          // input convert
  ppin[2]=pv*pi;                  // C point power
  if(ppin[2]>=ppin[1])       // C>=B
    tag1=1;
  else
    tag1=-1;
```

```
  if(ppin[0]>=ppin[1])       // A>=B
    tag2=-1;
  else
    tag2=1;
  tag=tag1+tag2;
  if(tag==2)
  {
    // not necessary to increase PWM, because already done.
  }
  if(tag==-2)
  {
    rref=rref+2*DRES;
    if(rref>(255-DRES)) rref=255-DRES;  // range limit
  }
  if(tag==0)
  {
    rref=rref+DRES;
    if(rref>(255-DRES)) rref=255-DRES;  // range limit
  }
  if(tag!=2)
  {
    if(dctype==0)
      Write_Res(0,rref);
    if(dctype==1)
      Write_Res(1,rref);
  }
}
```

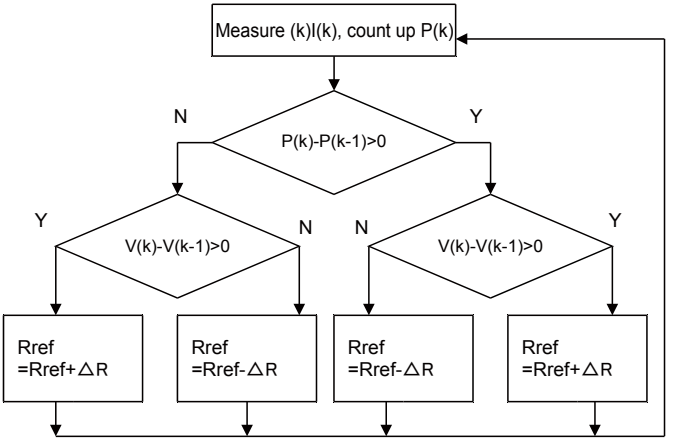
3. Design of Slope-comparison(SC)

(1) The slope-comparison (SC) is based on P&O. It is observed that the location is in the left or right of the Pmax. When on the left, the slope left is positive, on the right, the slope is negative. They are shown in the below Figure. That is, It determines the movement direction of working point by the change of solar input and power.



Slope change

The control process as the below.



The control processes of the SC

(2) The Circuit Design of the Hardware

Same default as the previous.

(3) The programs design of the Software

The main programs are same as the before. Here are only the processing programs of MPPT.

```
// MPPT processing
// SC
void  MPPT_Process()
{
  unsigned char i;
  for(i=0;i<3;i++)                    // for 3 times
  {
    Sensor();                 // polling reading sensor for display
    IN_Read();                        // input convert
    LOAD_Read();              // Output convert
    pvin[1]=pv;
    ppin[1]=pv*pi;
    if(ppin[1]>ppin[0])
    {
      dstime=0;
      ustime++;
      if(ustime>2)            // 3 times satisfied
      {
        ustime=0;
              if(pvin[1]>pvin[0])
              {
                rref=rref+DRES;       // resistor increasing,PWM decreasing
                if(rref>(255-DRES)) rref=255-DRES;
              }
              else
              {
                        rref=rref-DRES;          // resistor decreasing, PWM
increasing
                if(rref<DRES) rref=DRES;
              }
              if(dctype==0)
                Write_Res(0,rref);
```

```
                if(dctype==1)
                  Write_Res(1,rref);
                        ppin[0]=ppin[1];       // re-new record
                        pvin[0]=pvin[1];
              }
            }
    else
            {
              ustime=0;
              dstime++;
              if(dstime>2)              // 3 times satisfied
              {
                dstime=0;
                if(pvin[1]>pvin[0])
                {
                  rref=rref+DRES;  // resistor increasing,PWM decreasing
                  if(rref>(255-DRES)) rref=255-DRES;  // range limit
                }
                else
                {
                  rref=rref-DRES; // resistor decreasing, PWM increasing
                  if(rref<DRES) rref=DRES;          // range limit
                }
                if(dctype==0)
                   Write_Res(0,rref);
                if(dctype==1)
                  Write_Res(1,rref);
                        ppin[0]=ppin[1];               // re-new record
                        pvin[0]=pvin[1];
              }
            }
  }
}
```

5. Specification & Caution

Specification:

1. Solar chip board: 8V(Max) 787 mA (Max)- under the sunlight. If you are indoor under fluorescent illumination, it's not enough. Please use halogen lamps or other light source.
2. Rechargeable battery: no. 3 rechargeable battery x 4, 1.2V 800mA.
3. Adapter 9V 0.5A, positive pole inside.

Caution:

1. The product of the DC to AC function is only to provide users of solar energy conversion experiments. It can not provide for real life use.
2. The product of temperature and illumination functions are only for experimental reference. There is a certain difference with the fact. If you would like to improve the accuracy, will need to modify the program by yourself.
3. The halogen light with this product is only for simulating the sunlight. During the operation, the halogen lamp will become hot. Please do not contact it to prevent burns. At the meantime, avoid eye contact for too long to prevent eye injury.
4. This product is provided the no. 3 rechargeable batteries holder. Please do not put other type of battery to avoid danger.
5. The each terminal connection between the experiment of this product is for various modules. Please refer the operation to avoid a short circuit happen.
6. We should use the wind power generation kit in an open place. In order to avoid accident during the blades rotating. The whole experiment must be accompanied by teachers.
7. The product use solar panels. The maximum output voltage is 8V, current is 787mA. The total output power is 6 W.
8. The solar panels must have adequate exposure to sunlight or simulated light source for reaching the biggest voltage and current putput.
9. For each unit experiment, please allow the solar panels to maintain an enough sunlight or light source for completeing the operation.

10. The optional accsesories of this product: Halogen lamp and Wind power generation kit.
11. During the experiment, please make sure the input is rectified or un-rectified. The rectified power source input is P41. The un-rectified is P40.
12. The “Load module” may be hot during the wroking. Please pay attention to safety and not to remain a long time using.
13. The structure of solar panels is relatively weak. Please be careful during the use, collection and transportation. Do not drop or shock.
14. During using the halogen module, do not shake violently or quickly adjust lighting angle or orientation. Becuase the tungsten will produce heat and be broken easily.
15. If the solar panels are damaged by external force, we will charge the repair cost for the materials and replacement.
16. If you would like to recover the manufacturer default, please use the ICE to load the GREEN. HEX which in the Boot Loader file to the MCU.

6. Experiment Content

1.Experiment content

- Observe I/V, V/P and MPP characteristic curve of solar power module.
- Set the output I/V of the solar module according to the incident angle.
- DC to DC converter module design.
- DC to AC inverter module experiment.
- Basic load experiment to observe the solar module I/V change.
- Charging and discharging function of the battery.
- MPPT algorithm.
- Integrate all of the above experiments. So we can exactly understand regeneration and recycling of green power.

2. Teaching book content

Ch1. Instruction of green power

Ch2. Instruction of the lab

Ch3. Instruction of software development tool

Ch4. Learning C language

Ch5. Feature and basic experiment of MPC82E516

Ch6. Control of LCM display

Ch7. Control of analog to digital

Ch8. Control of PWM

Ch9. Theory of DC to DC

Ch10. Control of battery charging & discharging

Ch11. MPPT algorithm

Ch12. Design of DC to AC

7. Standard & Optional Accessories

Standard Accessories:

1.Main unit x 1

2.Adapter 9V~12V/500mA, positive pole inside x 1

3.USB cable x 1

4.10cm 2pin cable with 3.96mm terminal x 1

5.30cm 2pin cable with 3.96mm terminal x 2

6.34cm 3pin cable with 3.96mm terminal x 5

7.No. 3 rechargeable battery x 4

8.CD X 1

Optional Accessories:

1.Halogen lamp ,250W x 1

2.Wind power generation kit

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